

# Washington Department of Natural Resources Sustainable Harvest Calculation for Eastern Washington

## Staff Report

**To:** Sustainable Harvest Calculation (SHC) Steering Committee

**From:** Economics Team

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**Subject:** Discount rate in the Sustainable Harvest Calculation (SHC) for Eastern Washington

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*"Every graduate student should spend a fair amount of time immersed in the discount rate literature, if for no other reason than to feel decidedly uncomfortable the rest of their professional career when using any particular discount in a cost-benefit analysis" - R.G Cummings in Just et al., 2004, p. 586*

### Proposed Action

The SHC must select a discount rate parameter, which is a very important parameter that represents how the calculation should value future revenue relative to present-day revenue.

Reasonable arguments can be made to justify a discount rate within a policy and data supported range. This range can be determined by borrowing rates, lending rates, and the rate of return on DNR timber operations. The rate of return of eastside forests should serve as the upper bound of the data supported range. This is the maximum discount rate that can possibly be achieved on Eastside Forests.

Given a review of relevant policy, borrowing rates, lending rates, and rates of return, the policy and data supported range is between 1% and 2.7%. It is recommended that a sensitivity analysis be done with discount rates between 1% and 2.7% to see its impact on important metrics (e.g. harvest volumes, timber inventory, revenues) over time. Within that range, it is recommended that the board opt for a rate in the lower part of that range because of the long time-horizon of the SHC which results in exponentially more severe discounting of future generations when discount rates are higher.

### Background

#### Context

The Sustainable Harvest Calculation (SHC) uses mathematical modeling techniques to determine the sustainable level of timber harvest for the benefit of present and future trust beneficiaries. The calculation is provided to inform the Board of Natural Resources (BNR) in making prudent and sustainable harvest decisions.

To conduct this calculation, the SHC must select a discount rate parameter, which represents how the calculation should tradeoff current financial values against future financial values. The selection of a

discount rate for the SHC can be guided by economic theory and practice, but is ultimately a subjective decision, and it is important for decisions makers to understand what is being traded off and be informed by the discount rates selected by peer institutions.

### ***Objective***

Our objective in this report is to inform decision makers by:

- Describing what a discount rate is (and isn't)
- Identifying the feasible range of discount rates for the Eastside SHC

## **Discount Rate – What it is and Why it is Important**

### ***Discounting to compare alternatives***

The SHC is tasked with comparing the revenue streams that result from different management options. The timing of when revenues are received and costs are incurred are an important aspect in determining what management options are better than another. For example, implementing a 60-year rotation will have a very different stream of revenues and costs than implementing a 40-year rotation. A 60-year rotation will provide more revenue at harvest time compared to a 40-year rotation, but a 40-year rotation will provide harvest more frequently than a 60-year rotation. The SHC uses discounting to enable comparisons across options that have differences in the amounts and timings of when revenues and costs are incurred.

Discounting assigns a value today to revenue that will be received in the future. Because there is a time value to money, and people prefer to be paid up front rather than later. Discounting is needed to account for the time value of money.

The discount rate allows us to “convert” or “discount” future revenues into their present value equivalents – generally just referred to as Present Value (PV). By “converting” everything into present values, we can compare the revenue streams from different management options on the same basis. Simplified to the maximum extent possible, one can think of “discounting” as just converting everything into the same unit, which is present value (PV).

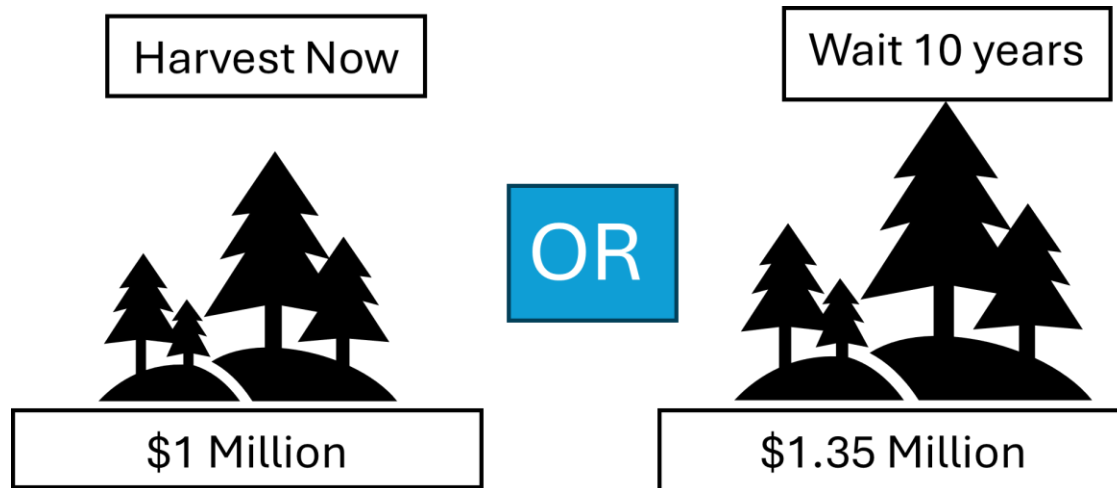
### ***Discount Rate in the SHC***

The Sustainable Harvest Calculation uses the discount rate to calculate the present value of a stream of costs and revenues, which is called Net Present Value (NPV). The general form of the formula is given below. The  $t$  in the formula stands for ‘time’ and is the number of years into the future that are being discounted. Using the discount rate to calculate NPV helps us to evaluate and compare options where the net revenues are accruing at different times and in different amounts. It converts all future moneys into a single number, and allows for straightforward comparison between management options. The management option with the highest NPV is most profitable for trust beneficiaries.

$$NPV = \sum_t \frac{Revenue_t - Cost_t}{(1+r)^t}$$

Example (Harvest Now or Later)

Suppose that DNR is faced with two choices for when to harvest a given stand of timber. We could harvest the stand right now for \$1 million or we could wait 10 years and get \$1.35 million in 2035. What is the optimal choice? Using the NPV framework, the option with the highest NPV is best. If waiting 10 years yields a higher NPV, it is optimal to wait 10 years and vice versa.



To see which option has the higher NPV, it is necessary to calculate the NPV of each option: Option 1: NPV of Harvest Now; and Option 2: NPV of Wait 10 Years.

Calculating NPV of Harvest Now Option:

$$NPV = \sum_t \frac{Revenue_t - Cost_t}{(1+r)^t} = \frac{\$1 \text{ million}}{(1+r)^0} = \$1 \text{ million}$$

Plugging in the values for revenue (\$1 million), cost (\$0), discount rate (r), and year (t=0). The net present value of getting \$1 million today is always \$1 million regardless of the discount rate at time t=0. So \$1 million dollars today is always worth \$1 million dollars in today's dollars.

Calculating NPV of Wait 10 years Option

$$NPV = \sum_t \frac{Revenue_t - Cost_t}{(1+r)^t} = \frac{\$1.35 \text{ million}}{(1+r)^{10}}$$

Plugging in the values for revenue (\$1.35 million), cost (\$0), discount rate (r), and year (t=10). The NPV of waiting 10 years depends on the discount rate.

Result

Below is a table of NPV calculation of waiting 10 years for discount rates between 2% and 4%. The NPV of waiting 10 years depends on the discount rate. If the discount rate is below 3%, a higher NPV can be achieved by waiting 10 years. If the discount rate is above 3%, a higher NPV is achieved by harvesting right now. Keep in mind that no matter what discount rate was chosen, the choice set of getting \$1

million now, or \$1.35 million 10 years from now does not change. The discount rate only changes the present value of \$1.35 million received 10 years from now. Higher discount rates means the present value of that future \$1.35 million is less than if we had a lower discount rate.

Table 1 – Example

r=	NPV Harvest Now	NPV Wait 10 Yrs	Optimal
2.0%	\$1,000,000	\$1,107,000	Wait 10
2.5%	\$1,000,000	\$1,1055,000	Wait 10
3.0%	\$1,000,000	\$1,000,000	Tie
3.5%	\$1,000,000	\$957,000	Harvest Now
4.0%	\$1,000,000	\$912,000	Harvest Now

### **Rate of Return Upper Limit**

Keep in mind that there is a biophysical upper limit to what the discount rate can reasonably be set to. A forest can only grow so fast and benchmarking a forest against a rate of return that it cannot reach will yield unsustainable results. The upper limit for a discount rate should be the maximum rate of return achievable by the forest asset, otherwise called the internal rate of return (IRR). This can be estimated by analyzing the growth and financial performance of the forest asset.

### **Discount Rates vs Rate of Return**

It is easy to mix up the idea of a discount rate with the idea of a rate of return. These are related concepts, but they are fundamentally different things. Definitionally, the rate of return is the annual percentage increase or return from some investment. Applying a discount rate to a future value to get its present value is essentially the opposite of applying an interest rate to a current value to get what it will grow to in the future. For instance, using some numbers from the example above, if you deposited \$1.00 million into an account at an interest rate of 3.0 percent compounded annually, then after 10 years you would have \$1.35 million. This is the same as if getting the present value of \$1.35 million paid in 10 years using a discount rate of 3.0 percent.

Because of this relationship, rates of return are often used as a discount rate in an analysis, and so people assume that discount rates *are* rates of return. To phrase the previous example from a different perspective, say a company were thinking of investing in a project that will pay out \$1.35 M in 10 years and the alternative for their investment capital was a bond that pays 3.5 percent. They might then say “we need to get at least a 4.0 percent return on this investment” to achieve a return that pays better than the bond rate<sup>1</sup>. They would analyze the project to find out its present value using a 4.0 discount rate, and would find that to get at least a 4.0 percent return, they would not spend more than \$0.91 million.

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<sup>1</sup> This targeted rate of return is typically referred to as a “hurdle rate” (Just et al.)

Another way to think of a discount rate is to consider it a desired rate of return (sometimes called the hurdle rate or benchmark rate) to compare against the actual rate of return of other investments.

For example, the rate of return for a 30 year treasury bond is currently 4.75% (Sept 2025). This is the rate of return I could get if I purchased a 30 year US treasury bond today. If I set the discount rate (benchmark) at 5%, the discount rate would be higher than the 4.75% rate of return of the bond. I conclude that the bond does not outperform my benchmark of 5% (it would also result in a negative NPV value).

On the other hand, if I set the discount rate at 4%, the 4.75% rate of return on the bond would be higher than my benchmark (resulting in a positive NPV). I can conclude that the bond investment is better than my benchmark of 4%.

The choice of discount rate does not impact the rate of return of the bond investment. My choice of discount rate is only there to help me evaluate how much better or worse it performs relative to the benchmark rate of return. The discount rate I choose has no impact on the rate of return of the 30 year bond. The 30 year bond rate is 4.75% regardless of if I choose a high or low discount rate in my financial analysis. The discount rate is simply the measuring stick; the rate I choose to use as my benchmark.

In the SHC, setting the discount rate higher does not make the trees grow faster, and it does not magically make more money appear from somewhere. A forest asset is not made more profitable simply by selecting a higher discount rate in a financial analysis. The discount rate is just the benchmark rate against which the forest asset's financial performance will be evaluated against.

### ***Long Time Horizon and Intergenerational Issues***

Lastly, there is the issue of long-time horizons and intergenerational equity when it comes to the SHC. The SHC solves for a very long horizon (100+ years) and considers tradeoffs spaced 60+ years apart (e.g. cost of silviculture treatment is incurred now, but the harvest revenue accrues 60 years in the future). It is not clear how relevant a market rate is to such long horizon decisions.

- Long Horizon: Borrowing and lending terms very rarely extend past 30 years There is no 60-year or 100-year term bond to compare against. The term length is definitely a factor in determining the rate, but long term rates are not observed in the market. It is not clear how wrong it is to use a 30-year rate for a 100+ year problem.
- Intergenerational: The lifespan of a beneficiary is shorter than the SHC's time horizon. For example, the costs of a silviculture treatment is incurred by beneficiaries alive today, but the revenue benefit will accrue 60+ years in the future, after those beneficiaries have passed away. The borrowing and lending rates in the market do not fully capture the intergenerational tradeoff inherent in the SHC.

Overall, this implies that adopting a market lending or borrowing rate as the discount rate would result in discounting that is too severe. In light of this, the SHC can be informed by them by considering the market rates more as upper limits. The discount rate should be lower than the rates observed in the market because the time horizon is long and there are intergenerational issues.

## Discount Rate Range

This section reviews the range of discount rates supported by policy, used by peer institutions, and relevant rates of return for the Eastside SHC. The rates used here are *real* – that is, adjusted for inflation unless otherwise noted.

### ***Forest Asset Rate of Return***

These are the rates that are specific to eastside forests managed by DNR and are the most relevant metrics informing the discount rate selection. These rates reflect the inherent performance of the asset itself. Other benchmark rates are determined in relation to other industries, timeframes, and risks. The set of rates presented here are specifically calculated from eastside forests managed by DNR.

#### *Eastside Forest Growth Rate*

##### **Growth Rate: 1.66% (MBF/Year)**

DNR estimated volumetric growth rates in Eastern WA using grown inventory plots. In this estimation, the plots were grown from the inventory year to 2025 and then from 2025 onward in 10 year increments. The estimated Volumetric Growth rate between 2025 and 2035 was estimated to be 1.66%. For details on the calculation and results, see report “Growth Rate Estimation EWA” (Hughes & Johnson, 2025). Using a discount rate higher than 1.66% would likely result in a harvest volume for the initial decade that cannot be sustained into subsequent decades.

#### *Eastside Forest Internal Rate of Return*

##### **Internal Rate of Return: 2.7%**

DNR also calculated an internal rate of return on a representative Eastside plot. The internal rate of return is the “break even” discount rate that results in NPV equal to zero. This represents the highest possible discount rate that can be achieved by the representative plot.

To calculate this rate of return, the following equation was solved with respect to the discount rate,  $r$ , and time,  $t$ .

$$NPV = \sum \frac{p * f(t) - c(t)}{(1 + r)^t} = 0$$

$r$  is the discount rate,  $p$  is a vector of timber prices,  $t$  indexes years,  $f()$  is merchantable timber volume, and  $c()$  is management costs. Since  $f()$  and  $c()$  are not continuous functions, the equation was solved algorithmically by evaluating different values of  $r$  and  $t$ . The solution was a discount rate of 2.7%. For details on the calculation and result, see report “Internal Rate of Return Calculation for EWA SHC” (Yi, 2025).

### ***Borrowing Rate***

While borrowing rates are considered, their relevance to the Eastside SHC is tenuous given the current operating environment. State government will not issue bonds to fund DNR timber operations, and it is unclear how municipal government or school districts would take on debt to resource timber operations. They enter into consideration here, but are not very relevant.

Municipal Bond Index

**Mean Rate of Return: 2.55% (nominal)**

Peers have suggested that DNR benchmark against municipal bond rates as a potential discount rate. This represents an average or indexed borrowing rate that is faced by local governments. Unfortunately, the bond buyers index, the data series that DNR has historically used, has been discontinued by the Federal Reserve (as of October 2016). As a substitute to the Federal Reserve Board’s discontinued index, we present the data below on returns from municipal bond indexes of select major investment firms.

Overall, these municipal bond indexes have had relatively low returns over the last 5 years. The average annual return on these indexes has been about 2.55% and has not kept up with inflation during this period. These rates reflect what happened during the pandemic period which may or may not reflect well on the real rates faced by municipalities. Nonetheless, this has been the 5-year performance of municipal bond indexes.

Washington State Bonds

**Rate of Return: 1.95%**

The TIC (True Interest Cost) of Washington State Bonds is interpreted as the rate of return here. The specific value of 4.45% (nominal) is the highest TIC of the bonds offered as of January 2025 (VPGO Bonds Series 2025C group 3). The nominal rate was deflated to yield a real rate of 1.95%.

**Investment Rate of Return**

While these rates of return are considered, they are not very relevant given the current regulations on how revenues are disbursed to trust beneficiaries. They do not allow DNR to invest revenue in lieu of payments to beneficiaries. We consider two alternative investments, but they are of limited relevance. Both alternatives are out of the scope of management actions that can be considered by the SHC. The SHC does not allow the possibility to sell or divest of a trust asset. The SHC does not allow withholding of revenues in favor of an alternative investment. These rates are considered here, but are of limited relevance.

Permanent Funds

**Mean Rate of Return: 3.37%**

Permanent funds also provide funding to trust beneficiaries. Benchmarking against alternative sources of funds could be a potentially useful benchmark, if funds could be redirected. The nominal returns for the funds below from 1993 to 2024 were supplied by the Washington State Investment Board. The annual average inflation adjusted returns for each are below.

Table 2: Real Annual Average Returns for WA State Trust Permanent Funds

Agricultural	Scientific	Common	University	Normal
3.37%	3.35%	3.40%	3.39%	3.35%

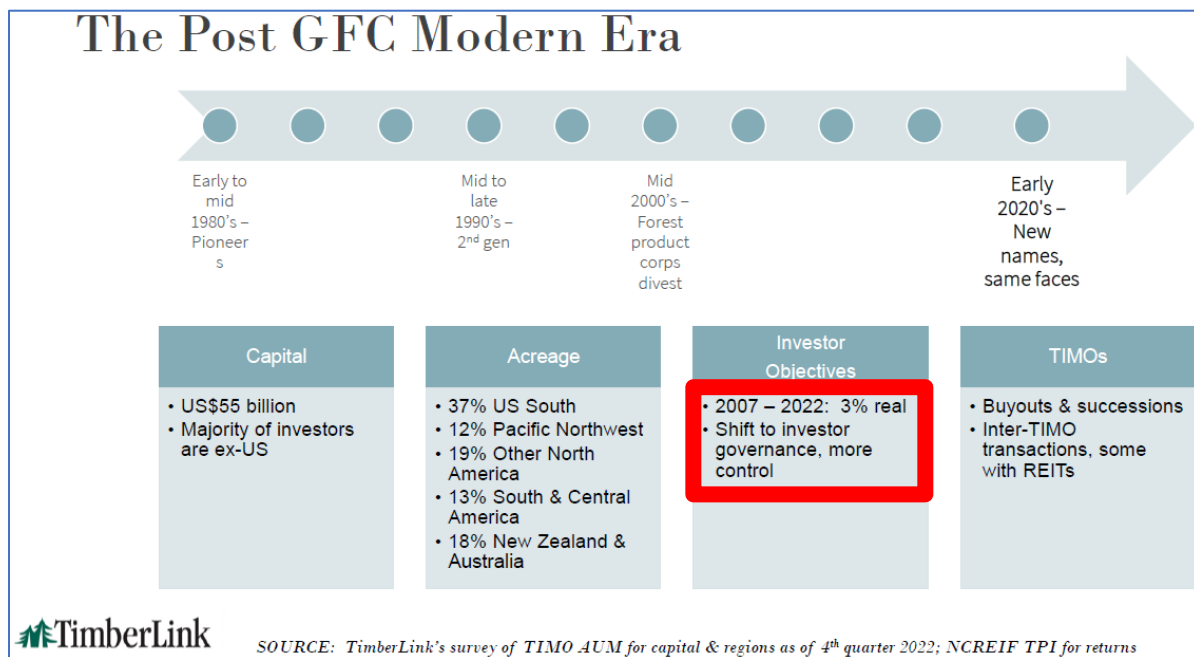
National Council of Real Estate Investment Fiduciaries Timber Portfolio

**Rate of Return: 3% (timberland); EBITDDA: 1.82% (2024 - nominal)**

As a simple benchmark, the rate of return on timberlands held in private trusts could be relevant. This would be relevant if the SHC could divest of a low-performing timberland asset and reinvest into an average performing timberland asset. A significant proportion of national timberlands are managed via Timberland Investment Management Organization (TIMO). These are third party asset or investment management entities that serve as a fiduciary and operate under a trust mandate, not unlike DNR's trust mandate.

The National Council of Real Estate Investment Fiduciaries (NCREIF) has a subdivision that is focused on timberland properties that produce a dataset on returns based on their data sources. In the summer of 2024, NCREIF gave overview presentations to stakeholders (NCREIF, 2024). The presentation reveals that TIMOs are targeting a 3% real rate of return (below). This appears to be generated from primary survey data or, at the very least, NCREIF's professional judgment. They reported a 1 year EBITDDA<sup>2</sup> on timberland assets in the Northwest region as 1.82%.

Figure 1: Investor Objectives



Source: (NCREIF, 2024)

### Discount Rates Used by Peers

A review of the discount rates and benchmarking rates of return used by public trust managers in neighboring states of Idaho and Oregon. We also include the discount rate used in Washington Department of Natural Resources in the previous Westside SHC. We also describe briefly what

<sup>2</sup> Earnings Before Interest, Taxes, Depreciation, Depletion, and Amortization. On timberland asset, this is likely earnings rate from timber sales, but it is not clearly defined in the reporting.

underpins the decision and interpretation of the selected rates highlighted in the table below as each state has taken a different approach.

Oregon Department of Forestry

**Discount Rate Range: 3% to 4%**

The Oregon Department of Forestry (ODF) uses a range of discount rates when setting the forest management plan. Oregon’s model solves using a real discount rate of 3% and 4% (Oregon Department of Forestry, 2023). The decision framework underpinning this specification are not outlined in the documentation. It should be noted that Oregon’s model has a strict even flow constraint that counteracts some of the less desirable impacts of having a higher discount rate.

Idaho Department of Lands

**Discount Rate: 3.35%**

In calculating the land expectation value (LEV), Idaho Department of Lands (IDL) uses a “real net income return target of at least 3.35%” (Idaho Department of Lands, 2024). This is the net return target used in IDL analysis and we interpret it here to be their effective discount rate.

Washington Department of Natural Resources

**Discount Rate: 3%**

The most recent SHC for Westside was implemented using a discount rate of 3%. This was informed by an internal document describing the defensible range of real discount rates between 1% and 4% (Chertudi, 2018). Decision makers selected a discount rate of 3% for final implementation.

**Policy Supported Discount Rates**

Washington State Institute of Public Policy (WSIPP)

**Discount Rate Range: 2-5%, Mode: 3.5%**

The Washington State Institution of Public Policy (WSIPP) provides general guidelines for a discount rates used in cost-benefit analysis across domains. It uses a different decision framework, but still provides a range relevant for consideration by the SHC. WSIPP recommends discount rates between 2% and 5%, with a mode of 3.5% (WSIPP, 2024):

- Low Rate: 2%
  - Based on rates used by the Council of Economist Advisors (2%), and the Office of the Informational and Regulatory Analysis (1.7%)
- Modal Rate: 3.5%
  - Based on rates used by the Congressional Budget Office rate for analyzing Social Security (3%) and cost-benefit analysis of early education (Heckman et al., 2010)
- High Rate: 5%
  - Upper limit recommended by (Moore et al., 2013)

United States Office of Management and Budget

**Intergenerational Discount Rate Range: 1-3%, OMB Recommended Discount Rate: 3% and 7%**

On August 7, 2025, the White House issued Executive Order 14332, “Improving Oversight of Federal Grantmaking” which, among other things, rolled back federal guidance on regulatory analysis (verbatim) to what was specified in the Circular A-4 of September 17, 2003<sup>3</sup>(Office of Management and Budget, 2003). The general federal guidance is to calculate net benefits using both 3% and 7%, but specifies that a lower rate should be used in the context of intergenerational discounting. The section titled *Intergenerational Discounting* states “Estimates of the appropriate discount rate appropriate in this case, from the 1990s, ranged from 1 to 3 percent” (Office of Management and Budget, 2003, p. 36). These numbers are in reference to the book “Discounting and Intergenerational Equity” (Portney & Weyant, 1999).

### Summary

A summary of the relevant rates are presented in the table below. The feasible range of discount rates the SHC can consider fall between 1% and 2.7%.

- 2.7% (upper bound): As previously stated, the upper bound for the discount rate is 2.7%. This is the “break even” discount rate on an average plot in Eastern Washington. Any discount higher than 2.7% will make NPV negative.
- 1% (lower bound): the lower bound is a policy supported rate. Federal guidance states that when there is intergenerational discounting, discount rates between 1% and 3% are appropriate. So, the lower bound for the SHC to consider appears to be 1%.

Table 3: Rates by Source

	Source	Rate
<b>Forest Asset Rate of Return</b>	Eastside Forest Growth Rate	1.7%
	<b>Eastside Forest Rate of Return</b>	<b>2.7%</b>
<b>Borrowing Rate</b>	Municipal Bond Index	2.6% (nominal)
	WA State Bond	1.9%
<b>Investment Rate of Return</b>	State Trust Permanent Funds	3.4%
	NCREIF (Timberlands)	3%
<b>Rates used by Peers</b>	Oregon Dept. of Forestry	3% - 4%
	Idaho Dept. of Lands	3.4%
<b>Policy Supported rates</b>	WA State Inst. Public Policy	2% - 5%
	<b>US Office of Mgmt &amp; Budget</b>	<b>1% - 3%</b>

<sup>3</sup> <https://www.whitehouse.gov/wp-content/uploads/2025/08/CircularA-4.pdf>

## Recommendation

The SHC must select a discount rate parameter, which is a very important parameter that represents how the calculation should value future revenue relative to present-day revenue.

Reasonable arguments can be made to justify a discount rate within a policy and data supported range. This range can be determined by borrowing rates, lending rates, and the rate of return on DNR timber operations. The rate of return of eastside forests should serve as the upper bound of the data supported range. This is the maximum discount rate that can possibly be achieved on Eastside Forests.

Given a review of relevant policy, borrowing rates, lending rates, and rates of return, the policy and data supported range is between 1% and 2.7%. It is recommended that a sensitivity analysis be done with discount rates between 1% and 2.7% to see its impact on important metrics (e.g. harvest volumes, timber inventory, revenues) over time. Within that range, it is recommended that the board opt for a rate in the lower part of that range because of the long time-horizon of the SHC which results in exponentially more severe discounting of future generations when discount rates are higher.

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